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Report to the
Government of

YUGOSLAVIA

WHEAT IMPROVEMENT

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
ROME, 1959



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REPORT

to the

GOVERNMENT OF YUGOSLAVIA

on

WHEAT IMPROVEMENT

by

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FAO Wheat Improvement Experts

Rome, 1959

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I. INTRODUCTION

At the request of the Government of Yugoslavia for technical assistance in the program to increase the production of wheat in Yugoslavia, the Food and Agriculture Organization of the United Nations appointed Dr. O. Bonfiglioli, Director, Ente Nazionale delle Sementi Eletti, Milan, Italy, on a part-time basis, and Dr. G. Gallarati-Scotti, Section Chief, SAICI, Torviscosa, Italy, Dr. V. Marchioneschi, Officer of the Alleanza Italiana Cooperativa Agricola, Pisa, Italy, and Dr. M. Trovisan, Officer of the Ministry of Agriculture, Ispettorato Provinciale di Verona, Italy, as full-time experts to advise and assist the Government in their wheat production program. Dr. Gallarati-Scotti has been working mainly in Vojvodina, Dr. Marchioneschi in Macedonia and Kosmet, and Dr. Trovisan in Serbia, Slavonia and Bosnia. Those experts served in Yugoslavia from 16 September 1957 to 30 September 1959. Dr. Bonfiglioli who, before he was appointed by FAO was already wheat advisor to Yugoslavia, has acted as leader of the team, and will carry on the work in 1960.

The terms of reference for the experts were to assist in the implementation of the Wheat Improvement Program, involving the distribution of imported seed, the adoption of improved cultural practices, application of fertilizers, improved harvesting procedures, and adequate seed multiplication schemes; also to assist in the formulation and maintenance of an appropriate program of experiments and tests.

The Government enabled the experts to visit different parts of the country to observe and advise on the testing programs by furnishing needed transportation facilities and arranging for frequent discussions with the agricultural officials.

The experts would like to express their gratitude and thanks to the President of the Union of the Chambers of Agriculture of the Central Government, to the President of the Chambers of Agriculture of the various Republics, to the officers of these bodies, to the Directors and agronomists of the Experimental Institutes and of the Agricultural Stations for their helpful, friendly, and wholehearted collaboration; to the Directors of the farming estates and to the agronomists who work on them for the understanding which they extended to the experts and for their enthusiastic cooperation.

II. BACKGROUND INFORMATION

As a background to the project the following might be mentioned concerning the agriculture in Yugoslavia before 1957:

The ownership and use of land was as follows:

Use of Land	State and Co-op Farms	Private Farms
Arable Land	664,000	6,856,000
Fruit and vineyards	35,000	637,000
Pastures and permanent grassland	267,000	3,928,000
Total	966,000	11,421,000
Percentage	7.8	92.2

Of the arable land 5,460,000 hectares (72.6 per cent) were under cereals, 535,000 hectares (7.1 per cent) under forage crops, and 620,000 hectares (8.9 per cent) on fallow, and the remaining 11.4 per cent mainly under industrial crops and vegetables. Of the area under cereals about 2,000,000 hectares were under wheat. The average yield of wheat and rye was 10.9 qt. per hectare.

The Yugoslav agriculture was thus characterized by a high proportion of cereals and much land under fallow and pastures, but with an insufficient area under leguminous fodder crops. Little care was given to grasslands and pastures and they gave a low yield. Nevertheless the number of domestic animals was fairly high. The stable manure was not adequately treated, was irregularly distributed and its benefit to crops was not as great as it could have been. The mechanization of agriculture was not much advanced. In 1955 12,676 tractors were in use, representing one tractor to 550 hectares, and the number of other machines was also comparatively low. The use of fertilizers of different kinds was also low, averaging only 34 kg. per hectare.

Experimental activities were carried out at the Institutes of Agricultural Research with good facilities, and at a considerable number of agricultural stations in which the extension service included some research work. Wheat breeding was carried out at institutes in Zagreb, Novi Sad, Staro, Osijek and Skopje.

In 1955 the Yugoslav Government started a program to improve the production in Vojvodina by distributing larger amounts of fertilizers and promoting more modern cultural practices. A considerable increase of yield was obtained, but it was thought that this could be improved even further.

A certain number of older Italian varieties, such as Salto, Virgillio, Tevere, Montana, Frassineto 405 and San Giorgio were already grown to a limited extent in certain regions, especially on the Adriatic coast, in Serbia and Macedonia, generally under rather poor local cultural conditions. In 1955-56 the variety Fortunato was tried out successfully.

In 1956-57 a great number of Italian and some Greek and Austrian wheat varieties were tested over fairly wide areas. The results indicated that many of the Italian varieties were adaptable to Yugoslavian conditions and that it would be possible to obtain high yields from them if suitable cultural practices were applied.

III. CLIMATIC AND PEDOLOGICAL CONDITIONS

Owing to its geographical position Yugoslavia has several distinct climatic zones, and, partly due to this, also a considerable range of soil types. The main climatic zones are:

1. Sub-alpine (part of Slovenia) characterized by low winter and relatively moderate summer temperatures, and also by very heavy, well distributed rainfall (1,000 - 1,400 mm).
2. Mediterranean (along the Adriatic coast) characterized by relatively narrow annual and daily range of temperatures; moderate rainfall concentrated mainly in the autumn and winter, though sufficiently high in the spring.
3. Continental (Vojvodina, Eastern Croatia, and the plains in the northeast of Serbia) characterized by wide annual and daily range of temperatures, low minimal winter temperatures, generally however not persistent; moderate total precipitation (500-700 mm), sufficiently well distributed throughout the year apart from frequent droughts in the summer months.
4. Central (mountainous area of Serbia), very similar as regards temperatures to the Continental zone.
5. Southern (Macedonia) with a more continental than Mediterranean influence. Temperatures are generally less severe in the winter and slightly higher in the summer, with variable rainfall according to the different areas, ranging from 400 to 700 mm with irregular distribution.

In relation to the analysed climatic conditions it is possible to place the distribution of the soil types throughout Yugoslavia. In the typical northeastern Continental zone, Vojvodina, chernozem with its various sub-types, dark meadow soils and black mineral swamp soils, as well as a certain percentage of saline soils are prevalent. In the northwestern part of the same zone, podzolized soils, typical podzol and brown soils are found. Thus from soils of excellent structure and fertility and generally with neutral reaction there is a gradual move towards often more compact soils, always less rich in humus and frequently with acid and sub-acid reaction.

In the Mediterranean zone, usually characterized by calcareous soils, often rich in pebbles.

In the central-eastern part, there is a gradual transformation from north to south of soils richer in humus and of very good or light structure to more compact and clayey soils (brown forest soils and smonitsa soils) which characterize the hilly regions and part of the plains of Serbia and Bosnia, as well as of Macedonia.

In all regions there are, especially near the great rivers, alluvial soils, particularly fertile and mostly of good structure. It has been demonstrated that all arable land of Yugoslavia is suitable for wheat

cultivation, although the best results have been obtained in chernozem, alluvial and black mineral swamp soils.

The growing season 1956-57 was fairly normal from the climatic point of view, apart from a persistent period of drought in the autumn which held up sowing operations and the sprouting of the wheat, and a second period of drought in the month of March.

In 1957-58 winter temperatures were considerably lower than normal in all areas, and the absolute minimum temperatures, even in December, were often as low as -19°C , and in January reached -20°C , with extremes of -24.3°C at Kragujevac. After a particularly mild period in February there was a new cold period in March with minimum temperatures reaching -15.8°C . A long period of drought occurred during May and part of June, which most unfavourably influenced the yields of the local varieties.

The season 1958-59 can be considered as normal for the greater part of Yugoslavia. The only circumstance of note was a shorter winter than usual, because of milder temperatures in March, and in some regions (Croatia, Slovenia, Bosnia, Macedonia) heavier rainfalls than normal in May and June.

IV. EXPERIMENTS CARRIED OUT AND RESULTS OF THE WORK
ON THE IMPROVEMENT OF WHEAT CULTIVATION

A. Background

At the commencement of the work detailed recommendations were given on the cultivation practices to be applied to the introduced varieties in order to make it possible for them to show to the full their yielding capacities. The most up-to-date techniques used in Italy were recommended at this point; at the same time experimentation on the various agronomic aspects of wheat cultivation was stimulated and on the basis of the results obtained the cultural practices suitable to the new varieties were to be gradually adapted to the ecological conditions of the different areas. These recommendations can be summarized as follows:-

- Better rotations with wheat following row crops, well fertilized with stable manure, or leguminous fodder crops if the land were ploughed a sufficient number of months beforehand.
- Gradual deepening of ploughing (to be carried out over several years) to a depth of 30 to 35 cm. especially in the regions with low rainfall and with clayey soil, possibly to be carried out for the preceding crop and in certain cases using sub-soils which are technically and economically advantageous.
- Better seedbed preparation with harrows and in some cases with rollers.
- Richer fertilization in relation to the physical and chemical composition of the soil, to the wheat strain being used, to rainfall, etc.; two-thirds of the amount of phosphate and potassium fertilizers to be distributed before ploughing.
- Higher seed rate than generally used hitherto in Yugoslavia and different seed rates depending on the strain used, differences in sowing time, etc.; the sowing time to be related to the physical characteristics of the varieties, the climatic conditions of the different areas and in general advised to sow earlier than in Northern Italy.
- Introduction in Yugoslavia of the system of winter top dressing with nitrogen (end November to beginning of March) on account of the biological cycle of most of the Italian varieties; the total amount of calcium nitrate or ammonium nitrate used for these purposes to be related to the soil and climatic conditions prevailing at the time, to the total amount of fertilizers, and to the wheat varieties used.
- Cultivation between rows, rolling and other cultural practices such as the use of weed-killers to be carried out in the spring.
- Earlier harvesting recommended for the introduced varieties on account of the susceptibility to loss of kernels of some of them.

B. Tests on Cultural Practices

At the seven chief agricultural experiment institutes a series of tests on cultural practices was carried out in 1957-58 and 1958-59. Three or four varieties were usually included (a local variety, San Pastore and Produttore or Fortunato, and in some cases, Autonomia) in order to observe their reaction to different cultural practices.

(i) Depth of ploughing: Treatments were generally as follows: 18 cm. (control); 25 cm; 35 cm. (only one ploughing); 35 cm. (3 ploughings); 45 cm. (one ploughing); 45 cm. (3 ploughings); 25 cm. plus 15 cm. subsoiling. Results differed considerably in the various tests and in the two experimental years. The highest yields were generally obtained with 25-35 cm., although in certain regions, especially in 1957-58 (dry spring), the highest yields were obtained with 45 cm. Repeated ploughings usually resulted in increased yields on chernozem but it is doubtful whether this method would be economically justified. On heavier soils one ploughing gave best results. These trials must be carried out for a longer period before a definite answer to this problem can be obtained.

(ii) Total amount of fertilizers: In these experiments six different amounts of fertilizers ranging from 7 to 24 quintals per hectare and with an N.P.K. ratio of 1:2:0.5 were compared with non-fertilized soils. The results obtained varied considerably in the different experiments due to many extraneous factors, including different climatic conditions, but it was possible to state that with Italian varieties the highest yields were obtained with amounts of 14-17½ quintals per hectare. The most economic results, however, were generally achieved with 14 quintals or somewhat less. These results, however, should not be generalized when being adopted for large-scale production, since injudicious use of nitrogen fertilizers can cause lodging. Local varieties invariably responded less to the high amounts of fertilizer than the introduced varieties.

(iii) Methods of top dressing: In these experiments the total amount of fertilizers was the same and the N.P.K. ratio was 1:2:0.5 in all treatments. A part of the fertilizers was, however, given as top dressings in accordance with the following methods:-

- (a) Yugoslav: 2 top dressings with nitrogen in March and April
- (b) Modified Yugoslav: Top dressings with nitrogen at end of November and February with nitrogen and phosphate in April and nitrogen and potassium in May
- (c) Italian: Five winter top dressings with nitrogen from end of November to end of February
- (d) French (Coïk): Three top dressings with nitrogen in March, April and May
- (e) Austrian (Kopotz): Top dressings with nitrogen end of February and March; with nitrogen and phosphate in April, and nitrogen and potassium in May.

The results obtained varied considerably in different areas, and so far no significant differences between the different methods of top dressings have been noted. In order to discover the most suitable method for each area and for each type of variety, these experiments should, therefore, be continued.

(iv) Seeding time: Six to eight varieties were used for these tests including the most widely distributed introduced varieties in the different regions and varieties with special physiological characteristics. Seeding was carried out from 5 October to 15 December at intervals of ten days. The highest yields were generally obtained when seeding was carried out between 15 and 25 October, but in 1958-59 when the following winter was very mild, the best results were obtained in some cases when seeding was done on 5 October. Care should be taken that seeding of varieties with spring growing habits should not take place too early (before 20-25 October) since cold winters seriously damage plants with rapid initial development.

(v) Depth of seeding: The following sowing depths were tested: 2, 4, 6, and 8 cm. and 6 cm. below a 6 cm. deep furrow. On lighter soils (chernozem) the best yields were obtained at 4 cm. (2-4-6 cm.) with Italian varieties and at 6-8 cm. with local ones. Seedings somewhat less deep gave higher yields on heavier soils. In large scale production damages by frost were more severe when seeding depth was more than 6 cm.

(vi) Seeding methods: The following tests with an equal amount of seed per surface unit were carried out:- single row at 13 cm; single row at 20 cm; cross row (distance of 13 cm. in both directions); double row with alternating distances of 25 cm. and 8 cm. The differences between these methods were generally insignificant and sometimes the various experiments gave contradictory results. There was, however, a tendency to slightly higher yields with the narrow single row system in light soils and with widely spaced single row or with the double row system in heavier soils.

The poor results obtained in these trials with the cross-seeding systems (with the exception of Zemun-Polje and Vojvodina) are in contrast to the observations made with statistical evidence for 1957-58 on the large scale production of this region. This is probably due to the fact that in large scale production, soil preparation is less thorough. In any case, only after several years of thorough trials will it be possible to ascertain the most suitable seeding system for each area and type of soil.

C. Varietal Trials

1. Small plot experiments:

In order to have a better orientation on the choice of the most suitable varieties for the ecological conditions of the different regions of Yugoslavia, 32 varietal small plot experiments had already been carried out in different parts of the country in the growing season 1956-57. These trials, as well as those conducted in succeeding years were under the control of the Federal Commission for the Approval of Varieties of Cereals and Other Crops. The trials were laid out in 5 sq.m. plots with five replications. The

following 32 foreign varieties were tested:

From Italy: San Pastore, Tevere, Montana, Funo, Fortunato, Fiorollo, Funone, Funotto, Falchetto, Frassineto 405, Autonomia B, Abbondanza, Mara, Generoso, Campodoro, Dragone, Freccia, Aquila, San Giorgio, San Luca, Produttore, R.37, R.16, Elia, Forlani, San Marino, Vivenza, V. Clavatino, Quaderna, Stirpe 1373.

From Austria: Harrach, Stamm 101.

From Greece: 46713, 38290, 46025.

In addition to these one or two of the following local varieties were included as control: U 1, Bankut 1205, Bankut 1201, Novosadska 1446, Rumska crvenka, etc.

In 1957-58 when the same number of tests were carried out the following varieties were withdrawn, due to their generally unsatisfactory yields in the previous year: Montana, Frassineto, Aquila, Dragone, Funone, Funotto, Stirpe 1373, Freccia, Quaderna, Harrach and Stamm 101. On the other hand the following were added:

Italian mountain varieties. Verna, Ovest, Est Mottin; and also I.Bo 911, I.Bo 1892, S.13 and S.15

French varieties: Etoile de Choisy, Cappelle Dosprez

Czech varieties: Pavlovicka, Kosutska.

In the 1958-59 trials Falchetto was maintained only in the Macedonian trials, and Verna, Ovest and Est Mottin only in the mountain trials. The two Czech varieties were withdrawn due to low yields, late maturing, and weak straw. The following new varieties were introduced: Marimp 3, Marimp 8, Orpas 2, Leono, Leonardo, T.22, S. 6r, I.Bo 904 and T.53.

During the three years continuous progress was made in methodology and in the more accurate execution of small-plot varietal experiments. For instance, instead of the linear method which was used entirely in the first year, a considerable number of experiments in the later years were laid out according to the randomized block method which gives more reliable results. An improvement was also made in cultural practices, which resulted in continually increasing yields. Increased attention was given to making the trials more representative, and for that purpose they were planted in various soil types, even in anomalous soils (saline, very acid, etc.). Greater attention was also given to their sequence in the crop rotations prevailing in the different areas. In Table 1 the average yields of the two growing seasons, 1957-58 and 1958-59, are given. The results are grouped under the most important cereal regions of Yugoslavia. Those of Slovenia are not included as only a reduced number of varieties was tested in this part of the country. Very often different local varieties were used in the different trials. A few varieties were not included in the trials of some of the regions, making the information concerning these varieties somewhat incomplete.

Table 1 - Average of 2-year yields (Kg/Ha) of small plot experiments

Varieties	SILOVANIA		VOJVODINA		SERBIA		KOSMET		BOSSNIA		MACEDONIA		Average	
	No. of trials	1957-58	2	6	2	6	2	2	2	2	4	4	21	
	1958-59	2	6	2	6	2	2	2	2	2	4	4	24	
S. Pastore	65.9	(1)	61.8	(3)	56.4	(9)	61.2	(1)	54.0	(4)	59.2	(4)	59.5	
San Marino	57.9	(7)	59.8	(9)	55.0	(12)	58.3	(9)	61.2	(1)	56.4	(3)	58.7	
I Bo 911	60.5	(5)	61.6	(4)	60.1	(2)	51.8	(7)	59.1	(1)	59.1	(1)	58.6*	
Etoile de Choisy	57.5	(10)	64.8	(1)	59.1	(4)	59.4	(2)	52.0	(17)	57.9	(7)	58.4	
Funo	57.1	(11)	61.0	(7)	54.4	(14)	58.6	(7)	51.3	(8)	54.5	(10)	56.6	
Abbondanza	63.1	(3)	58.5	(14)	58.3	(5)	58.6	(6)	45.2	(17)	56.0	(4)	56.6	
R.37	60.0	(6)	61.2	(5)	58.5	(4)	58.2	(10)	45.7	(16)	52.5	(16)	56.6	
Elia	53.3	(18)	64.2	(2)	62.7	(1)	58.5	(8)	47.0	(14)	53.0	(14)	56.9	
Produttore	55.6	(14)	60.3	(8)	58.9	(3)	58.9	(5)	49.7	(9)	54.8	(8)	56.5	
San Luca	53.7	(17)	58.8	(11)	59.1	(2)	60.0	(3)	47.1	(13)	55.2	(6)	55.9	
Fortunato	59.9	(7)	55.8	(20)	51.6	(16)	56.7	(15)	52.7	(5)	54.7	(9)	55.5	
San Giorgio	55.3	(15)	58.7	(12)	56.9	(7)	57.7	(12)	54.3	(3)	52.8	(15)	55.5	
Generoso	63.3	(2)	61.1	(6)	57.9	(6)	56.9	(14)	39.8	(23)	53.1	(15)	55.3*	
Autonomia	60.6	(4)	56.9	(16)	55.6	(10)	55.1	(17)	49.2	(10)	53.9	(13)	54.7	
Campodoro	49.0	(22)	59.5	(10)	56.5	(18)	56.0	(16)	49.0	(11)	55.3	(5)	54.5*	
Fiorello	54.7	(16)	58.5	(13)	56.5	(18)	57.6	(13)	47.4	(12)	53.2	(13)	54.4	
Impeto	56.2	(12)	56.1	(19)	52.1	(15)	58.1	(11)	42.5	(21)	53.4	(12)	53.9	
R.16	57.8	(9)	56.2	(18)	55.3	(11)	54.5	(18)	44.1	(19)	53.5	(11)	53.2	
S.15	50.4	(20)	55.0	(21)	58.1	(15)	53.0	(21)	52.0	(6)	50.9	(20)	51.9*	
S.13	49.8	(21)	58.1	(15)	53.2	(20)	44.9	(18)	54.8	(7)	50.2	(19)	51.8*	
Tevere	56.0	(13)	56.8	(17)	54.6	(13)	53.6	(19)	42.4	(22)	51.4	(19)	51.8	
V. Clavatino	47.3	(23)	51.9	(22)	44.3	(17)	49.8	(23)	42.8	(20)	46.5	(21)	48.8*	
Forlani	52.2	(19)	50.2	(23)	43.6	(18)	50.1	(22)	45.9	(15)	46.1	(22)	48.0*	
Cappelle Desprez	47.1	(24)	47.6	(24)	49.8	(24)								
Local Control					46.7	(25)								
Bankut 1205					40.5	(25)								
U 1					35.2	(19)	44.7	(25)	41.8	(24)	38.8	(23)	40.9	
Other local varieties											39.0	(21)		

The figures in brackets represent the grading of varieties.

* Average for lower number of experiments.

The highest average yields have been obtained from San Pastore, San Marino, I.Bo 911, Etoile de Choisy, Abbondanza, Funo, R.37, Elia, Produttori and San Luca; among these San Pastore, I.Bo 911, San Marino and, to a lesser degree, Abbondanza and Etoile de Choisy are conspicuous for their high yields in all districts and in both years.

Certain varieties, although showing less adaptability in some areas, gave very good results in other zones. Among these should be mentioned Elia in Vojvodina and Serbia, Generoso in Slavonia and Vojvodina, Fortunato in Slavonia and southern regions, and Campodoro, Funo and R.37 in Macedonia. The other varieties would not appear to be suitable for large-scale cultivation in Yugoslavia. Some of them, however, have shown interesting characteristics which make them suitable for hybridization. For instance, Forlani has exceptionally high ear fertility; Mara, S.13 and S.15 excellent resistance to lodging; S.13 very good baking quality; and S.15 a high percentage of gluten. Table 2 shows the average yields obtained in 1958-59 from new varieties tested in Yugoslavia. Local control varieties which varied according to the region and three varieties which gave specially good results in previous years are included for comparison. It is immediately apparent that the yields of these varieties in 1959 proved to be considerably superior to those of the two years' average. This is chiefly due to the better climatic conditions of this last growing season. The increase in yield of San Marino was, however, much less than that of the other two varieties because of greater damage caused by lodging in the last rainy spring. Of the nine Italian varieties tested for the first time, Marimp 8, Marimp 3, Leonardo, Leone and T.22 seem to be of great interest, while the other four are less promising. Marimp 8, Leone and T.22 gave the best results in northern Yugoslavia and Marimp 3 and Leonardo were best in the south and on poorer soils. The difference in yields between the tested varieties and the local ones was considerable in all regions. In some of the trials in Macedonia, however, Skopje 21 has given good results.

In Slovenia ten small-plot experiments have been carried out each year, most of them with a limited number of varieties (10 to 11), not all of which were included in every trial. San Marino, Etoile de Choisy, Verna, and the Austrian variety, Helkorn, gave the best results in the mountainous area, and Funone, Leone, T.22 and Leonardo in the regions with low hills.

2. Large-plot variety trials - demonstration experiments.

In order to test the adaptability of the most promising introduced varieties under normal field conditions, about 40 large-plot trials have been carried out in the different parts of Yugoslavia in each of the past three years. In these trials 8 to 12 varieties were generally tested, including 1 or 2 local varieties as controls. The varieties were sown in parallel strips each covering about one hectare on as uniform soils as possible, and over an area which was more or less square. The trials were laid out without replicates, and the amounts of fertilizers varied according to the natural fertility of the soil. These trials gave very useful indications on the behaviour of the tested varieties under conditions similar to large-scale cultivation, and represented a necessary complement to small-plot experiments, especially if results are considered not as those of single trials but as an average for an area where similar conditions prevail. In addition the

Table 2 - Results of the newly introduced wheat varieties in the small-plot experiments of 1958-59

No. of trials 1958-59	SLAVONIA	VOJVODINA	SERBIA	KOSMET	BOSNIA Herzegovina	MACEDONIA
	2	6	North Central-South	2	2	4
<u>Control varieties</u>						
S.Pastore	69.8 (1)	65.7 (5)	58.9 (6)	68.0 (7)	63.8 (2)	68.2 (4)
S. Marino	58.2 (8)	59.5 (10)	59.8 (5)	56.1 (12)	61.3 (4)	64.6 (7)
Etoile de Choisy	65.1 (4)	66.8 (2)	65.8 (3)	68.8 (5)	64.5 (1)	65.1 (10)
<u>Varieties</u>						
Marimp 8	66.2 (3)	66.5 (3)	68.5 (1)	72.4 (4)	58.6 (6)	75.0 (1)
Marimp 3	61.9 (7)	64.5 (6)	56.8 (7)	75.4 (2)	53.4 (10)	73.8 (2)
Leonardo	63.4 (6)	62.0 (7)	54.3 (8)	76.4 (1)	61.5 (3)	68.4 (3)
Leone	63.5 (5)	67.0 (1)	60.4 (4)	73.5 (3)	57.9 (8)	64.8 (6)
T.22	66.8 (2)	66.1 (4)	66.0 (2)	68.7 (6)	59.6 (5)	65.8 (5)
S.6r	55.2 (10)	61.3 (8)	53.7 (9)	63.5 (9)	55.5 (9)	59.4 (9)
R.904	58.2 (8)	60.5 (9)	53.4 (10)	65.9 (8)	49.2 (11)	55.8 (11)
Orpas 2	54.3 (11)	59.1 (11)	50.0 (12)	61.5 (10)	58.5 (7)	56.0 (10)
T.53	52.2 (12)	56.6 (12)	50.4 (11)	56.8 (11)	25.9 (13)	52.5 (11)
<u>Local Control Varieties</u>						
U.1	43.3 (13)	49.8 (13)	33.3 (13)	51.0	38.9 (13)	38.9 (13)
Bankut 1205						
Skopje 21						
Other Local Varieties						
					44.9 (12)	44.9 (12)
					51.6 (12)	51.6 (12)
						44.7

The figures in brackets represent the grading of varieties.

large-plot experiments also had the aim of:-

- a) facilitating better observations on resistance to frost, lodging and diseases,
- b) permitting, in many cases, through the application of varying rates of fertilizers, in strips right-angled to those of the varieties, the integration of results of the exact trials carried out by the institutes, insofar as amounts of fertilizer and, in certain cases (e.g. Vojvodina), methods of top dressing are concerned,
- c) demonstrating to agronomists and private farmers the results obtained by the combination of high-yielding varieties and up-to-date cultural practices.

It can be stated that, in general, the results of these trials correspond to those obtained in the small-plot experiments, so far as grading between varieties is concerned. There are, however, some exceptions, especially with varieties in which the growth is more favoured by light. For example, Elia, Bankut 1205, San Marino, R.16, San Luca, Autonomia B, etc., did not give such satisfactory results in the large-plot experiments as in the small-plot experiments. It was found that generally varieties with a lower resistance to lodging, as characterized by some of the varieties mentioned above, do better in small-plot experiments.

3. Special observations:

Apart from studies on the yielding capacity of introduced varieties, a series of observations on other characters was necessary to complete the evaluation of each variety to be introduced into large-scale production. Such observations were made both in small-plot and large-plot experiments, and partly also in special experiments carried out for this purpose at a number of institutes. Characters of special interest were resistance to frost, lodging and the more important diseases. In order to obtain an accurate evaluation of resistance to frost, experiments with the Aufhammer system were conducted. This consists of sowing varieties to be tested in wooden cases raised to a height of 1 metre from the soil and covered when snowing. As far as resistance to lodging is concerned, the most reliable observations were carried out on the large-plot experiments. Observations on resistance to stem and leaf rust were carried out in nearly all small-plot experiments in accordance with the standard methods. The type of infections were also studied.

Most of these observations were carried out by the Yugoslav wheat specialists in collaboration with the FAO experts.

A summary of the main characteristics of the tested varieties is given in Table 3. It can be stated that the French varieties, Etoile de Choisy and Cappelle Desprez, and the Italian varieties, Elia and San Pastore, and the Czech variety, Kosutska, showed about the same resistance to frost as the local varieties. Autonomia B, Fiorollo, S.15, San Marino and V. Clavatino also proved to be very good in this respect, and many of the other varieties were sufficiently resistant, even in the coldest regions of the country. It would, however, be advisable to exclude from large-scale cultivation in these regions the varieties Mara, Forlani, R.37 and T.53 which proved very sensitive

Table 3 - Important characteristics of wheat varieties tested in Yugoslavia

Variety	Yield-	Regul-	Adapt-	Resistance to							Baking Quality
	ing capacity	arity of yield	ability	Frost	Lodging	Leaf Rust	Stem Rust	Mildew			
S. Pastore	A	A	A	A/B	C	E	C	C/D	C/D	-	C ₁ /C ₂
Tevere	D	B	B	E	C	F	A	D	-	-	-
Salto	D	B	D/C	E	C	G	C	D	-	B ₂	-
Marimp 3	A	-	{B}	D	C	C	D	B	B	B ₂	-
Marimp 8	A	-	{B}	E	A	B	B/C	B	B	B ₂	-
Orpas 2	C	-	E	B	A	E	D	E	E	-	-
Fortunato	A	C	D	E	B	E	E	D	D	B ₂	C ₁
Funo	A	B	B	D	A/B	F	A	E	E	-	B ₁
Fiorello	B/G	B	C	B	B	F	E	F	F	-	-
Funone	A	C	C	B	A	E	E	E	E	-	-
Funotto	A	C	C	D	B	D	E	E	E	-	-
I Bo 911	A/B	B	B	C/D	B/C	C/D	D	D	D	-	-
I Bo 904	C	C	C	D	F	C	A	B/C	B/C	-	-
Produttore	A	C	D	D	P/C	B	A/B	E	E	C ₁	-
S. 6r	A	-	(D)	E	B/C	B	B/C	C/D	C/D	-	C ₂
R.37	A	D	D	F	A	B	A	D	D/E	C ₁	-
R.16	C	C	B	D	D	F	A	F	C/D	-	**
S.15	C	B/C	E	B	B	D	B	F	B	-	-
S.13	B	B/C	D	C	B	B	D/E	F	C/D	B ₂	-
S. Luca	C	C	C	D	C	B	B	A	B	-	-
S.Giorgio	C	B	C/D	D	B	B	B	A	B	-	**
T.22	A	-	(B)	D	B	B	A	A	B	-	-
Mara	A	B/C	D	E/F	A	B/C	B	C	C	B ₂	-
Abbondanza	A	A	B	D	B	C	C	C/D	C	B ₁	-
Autonomia B	C	B	B	B	E	D	D	C/D	C	B ₁	-
Generoso	A	C	E	E/F	B	C/D	B	C	C	-	-
Campodoro	A/B	C	E	E/F	A	C	B	D	D	-	-
Impeto	B/C	B	B/C	D	D	C	A	D	D	-	-
S. Marino	B	A	B	B	D/E	C	C	C/D	C	-	-
Forlani	D	E	E	F	F	F	B	B	B	-	-
Leone	A	B	B	C	B	C	A	A	B	-	-
Leonardo	A	B	B	B	D	D/E	D/E	D/E	D/E	-	-
Clavatino	C	E	C	B	D/E	A	A	A	B	B ₂	-
Elia	B	C	B/C	A/B	D/E	A	A	A	B	-	-
Ovest *	D/E	B	-	A/B	F	C/D	-	-	-	-	-
Est Mottin *	E	B	-	A/B	F	B	E	E	E	-	-
Verna *	C/D	B	-	A/B	F	D	D	D	B/C	-	-
Heikorn *	B	B	-	-	-	-	-	-	-	-	-
T.53	C	-	(A)	-	-	-	C	C	C	-	-
Etoile de Choisy	A	A/B	B	A/B	D	C	A	D	D	-	***
Cappelle	C	C	D	A/B	B	C	C	C	E	-	-
Falchetto	A	C/D	E	F	A/B	D/E	-	-	E	-	-
Bankut 1205	E/F	B	B	A	E	F	C	C	C	B ₁	-
U 1	D	C	C	A/B	E	E	E	E	C	C ₁	-

A - Excellent D - Fair
 B - Very good E - Poor
 C - Good F - Very poor

Evaluations in brackets refer to varieties not yet sufficiently tested.

* - Varieties for mountainous areas
 ** - Good baking quality according to Italian investigations
 *** - Medium good baking quality according to French investigations

to frost, and also to limit so far as possible the use of Impeto, Fortunato, S. 6r and Marimp 8, although some of those produced very high yields in some of the trials even after the coldest winters (i.e. Vojvodina). Fortunato also gave high yields in large-scale production. Resistance to lodging which is an essential factor under intensive farming conditions was especially high in Campodoro, Mara, R.37, Funo, Marimp 8 and Orpas 2. It was also good in most of the other Italian varieties with the exception of the mountain types, Verna, Ovest, Est Mottin (when cultivated in the plains), Forlani, I.Bo 904, Autonomia B, V. Clavatino and San Marino. Cappelle Desprez showed good resistance to lodging, whereas low resistance was observed in Etoile de Choisy and also in the local varieties.

The only varieties which showed real resistance to the prevailing races of leaf rust were Elia, the local Novosadska 1993 and, to a slightly lesser degree, Cappelle Desprez, while Produttore, S.6r, R.37, S.13, T.22, Mara, Leone, Marimp 8 proved fairly resistant. Among the varieties which proved to be susceptible to leaf rust and which were rather badly attacked were San Pastore and Fortunato. In spite of this these varieties have reached high yields in both trials and large-scale production. This seems to be due to the fact that also in years characterized by heavy attacks (1958) and in the regions most badly attacked, damage was serious only in exceptional cases, as the occurrence of this disease was generally rather late (20 May to beginning of June) when early-maturing varieties did not suffer so greatly.

Etoile de Choisy, Tevere, Impeto, Funo, I.Bo 904, R.16, R.37, T.22, Leonardo, Elia, V. Clavatino, and to a lesser degree, Produttore, Cappelle Desprez proved to be resistant to the prevailing races of stem rust. A great number of other Italian varieties showed moderate sensitivity, with the exception of the high sensitive varieties, San Luca, S.15 and Fiorollo. The areas most badly attacked by stem rust were Croatia and Central Serbia, although a rather heavy but late attack (mid-June) occurred also in Vojvodina in 1959. All local as well as newly-introduced varieties proved to be more or less susceptible to *Erysiphe graminis*. Among the less susceptible were Elia, Leone, T.22, S.13, while Fiorollo, S.15, Orpas 2, Funo, Produttore, and Est Mottin were more heavily attacked.

4. Large-scale production:

A few hundred hectares in Slavonia and Vojvodina had already been sown with Italian wheats in the growing season 1956-57, and the varieties selected, believed to be the most suitable, were San Pastore, Autonomia B, Produttore and Fortunato in the North, and San Pastore, Autonomia B, Mara, San Giorgio and R.37 in the South. As a result of the very promising results obtained the large-scale cultivation of introduced varieties was extended to about 40,000 ha. in all regions of the country in 1957-58. All these varieties showed good and even very good adaptability. Abbondanzo and San Marino were also introduced into large-scale cultivation in Serbia in the same season, and San Marino into the various mountain regions. The production was very satisfactory in spite of the fact that year climatic conditions were not at all favourable. The average yield from the 40,000 ha. with Italian wheats gave an average yield of about 35 quintals per hectare, as compared with the average yield of local varieties of about 11 quintals per hectare.

In 1958-59 approximately 315,000 hectares were sown with Italian wheat varieties. According to the official estimate at the end of July a total yield of 12.0 million quintals was expected, which corresponds to an average yield of 38.7 quintals per hectare. In the same year the estimate of the total production of the 2,130,000 hectares sown to wheat was 40.3 million quintals, corresponding to 17.4 quintals per hectare. From this estimate it can be deduced that the average yield of the local varieties was about 14.1 quintals per hectare. It can also be observed that whereas the area under newly introduced wheat varieties represented only 15.5 per cent of the entire area under wheat, their part of the overall production reached nearly 30 per cent. Tables 4 and 5 give summaries of the yields obtained in 1957-58 and 1958-59 according to a statistical analysis made in the different regions on part of the area with those varieties. This is mainly based on fields chosen at random, although more frequently from State and Cooperative farms. Only the yields from Slavonia in 1957-58 refer to yields of crops destined for seed production.

Table 4 - Large-scale production recorded in 1957-58

Variety	Slavonia q/ha.	ha.	Vojvodina q/ha.	ha.	Serbia and Kosmet q/ha.	ha.	Macedonia q/ha.	ha.
San Pastore	51.6	2,796	41.9	4,762	36.5	950	30.0	357
Autonomia B	44.9	612	40.0	1,394	45.0	317	28.0	100
Produttore	49.7	306	41.1	722	40.8	267	31.0	76
Fortunato	50.8	771	42.0	996				
Abbondanza	51.1	42			33.0	179		
Mara							40.0	125
Impeto	42.9	48						
S. Giorgio							30.0	500
R.37							33.0	169
R.16					38.2	109		
U.1 (local)	36.3	1,927						

Table 5 - Large-scale production recorded in 1958-59

Variety	Slavonia q/ha.	ha.	Vojvodina q/ha.	ha.	Serbia q/ha.	ha.	Bosnia and Herzegovina q/ha.	ha.	Macedonia q/ha.	ha.	Kosmet q/ha.	ha.
S.Pastore	49.4	5,890	50.0	9,965	47.5	12,772	40.5	1,112	39.5	457	40.1	333
Autonomia B	38.7	222	46.1	1,175	37.9	4,008	31.9	262	32.2	77	33.9	176
Produttore	50.2	544	49.1	1,402	40.1	3,232	36.4	406	36.2	151	34.7	107
Fortunato	49.9	1,398	49.5	1,703	46.1	235	47.8	30	38.0	27	35.6	76
Abbondanza	59.3	54			37.9	4,008						
S.Giorgio									28.5	329		
Mara									33.8	79		
Funo											31.8	113

In Slovenia the average yield of the Italian varieties and of the Austrian Helkorn was 30.2 quintals per hectare.

It must be pointed out that the production figures of the different varieties given in the tables are not directly comparable because of the different conditions under which the varieties are grown. For instance, Autonomia B gave on the whole lower yields than the other varieties whereas the yields of San Pastore, Fortunato and Produttore were maintained. Owing to its great adaptability and lower fertility requirements, however, Autonomia B was often grown on the poorest soils without intensive cultural practices. On the other hand, Fortunato and Produttore were generally grown in the best soils and with more fertilizers.

In Table 6 the average yields of the introduced varieties are summarized for the different regions in 1958-59, grouped according to the different types of farms.

Table 6 - Average yield of the introduced wheat varieties on different types of farms in 1958-59

	State Farms		Cooperative Farms		Private farms (cooperating with Cooperatives)	
	q/ha	ha	q/ha	ha	q/ha	ha
Croatia	49.4	2,390	44.2	2,354	47.0	284
Vojvodina	47.1	44,054	45.3	46,539	38.7	33,822
Serbia	50.4	6,593	45.6	3,946	39.4	11,736
Bosnia and Herzegovina	41.0	1,186	31.2	142	36.2	883
Macedonia	32.6	521			37.0	598

State farms nearly always show the highest figures, because they are invariably under the direction of agronomists, have a greater proportion of machines and make a more intensive and better use of fertilizers. The higher production of the private farms in Croatia compared with the cooperative farms cannot be considered as a general average on account of the differences in areas covered. In Macedonia the difference depends on the fact that while the fields of private farmers were generally on good quality soils, the state farms included fields grown with wheat for the first time.

5. Final consideration of varieties:

The following conclusions can be made from the preceding chapters:

(i) The varieties already introduced into large-scale production gave on the whole very good results, both from the point of view of their high yielding capacity and of their consistent production. It should, however, be kept in mind that in the coldest regions of north Yugoslavia, Fortunato should not be too widely spread on account of its sensitivity to frost, whereas in Macedonia, San Giorgio should be gradually eliminated on account of its low yields, and N.37 on account of its unreliable yield and its low baking quality. These two varieties could eventually be limited to those small areas where they have proved clearly superior to other varieties.

(ii) San Pastore has shown consistent and high yields under all growing conditions in Yugoslavia and Autonomia B proved always to be adaptable to poor soils and to less advanced cultural conditions. Other varieties such as Produttore, Mara, Generoso, Campodoro and Fortunato should be limited to regions with richer soils in the north and to a lesser degree in the centre of Yugoslavia where they have given the best results. San Marino should be limited to the hilly and less fertile regions.

(iii) A factor which should increasingly be considered in the future with the gradual diminution of local varieties is that of baking quality of the introduced varieties, especially as most of the local varieties are very good in this respect. For this reason it would be advisable to restrict to a limited degree the extension of San Pastore which, although giving high yields, shows rather poor baking quality. On the other hand Autonomia B should be extended in the regions with poorer soils and with less developed agriculture, and Abbondanza in medium and good conditions of soils and agriculture, as both have very good baking quality. Great attention should be given to some of the varieties tested for the first time in the Yugoslav small-plot experiments of 1958-59, as apart from their very good yielding capacity and resistance to lodging and diseases, they present very good baking qualities.

(iv) Etoile de Choisy on account of its high yielding capacity, consistent productivity and resistance to frost merits introduction in large-scale production in all areas having medium fertility. Owing, however, to its mediocre baking qualities it does not seem advisable to extend it too widely.

V. WHEAT IMPROVEMENT IN YUGOSLAVIA FROM ITS ECONOMIC ASPECTS AND ITS EFFECT ON THE DEVELOPMENT OF YUGOSLAV AGRICULTURE AND AGRICULTURAL INDUSTRIES.

Economic Considerations

The economic advantages of the introduction of new varieties and adoption of improved cultural practices seem to be clear considering the great difference in yields between these crops and the average yields of the country. It seems evident that from an economic point of view also the introduction of the new varieties and the up-to-date cultural practices are advantageous, even taking into account the greater expense involved in the cultivation of these varieties in better prepared soils, larger applications of fertilizer, more careful cultivation, and higher harvesting costs, etc.,. It is of interest to summarize here a study carried out by the Institute of Agricultural Economy at Belgrade, since it gives a clear demonstration of these economic advantages. These data refer only to the growing season 1957-58 as those for 1958-59 have not yet been fully worked out. The investigation was based on results from 39 State farms with wheat fields varying from 25 ha. to 200 ha. The whole study referred to 2,382 ha. of Italian wheat on 28 farms and to 646 ha. of local varieties on 14 farms. The results of the study were as follows:-

	Varieties		Difference	
	Local	Italian	Amount	Percentage
Average yields of q/ha.	25.89	43.34	+ 17.45	67%
Value per ha. in dinars	110,751	183,716	+ 72,965	66%
Production costs per ha. in dinars	91,955	110,720	+ 18,765	20%
Profit in dinars	18,796	72,996	+ 54,200	

The average production cost per quintal was, for the Italian wheats, 2,399 dinars, and for local wheats, 3,250 dinars. The average profit per quintal would be 1,479 dinars for the Italian wheats and 658 dinars for local wheats. According to the study the profit per 100 dinars spent would be 66 dinars for Italian wheat and 20 dinars for local wheat.

VI. THE GENERAL DEVELOPMENT OF AGRICULTURE
IN YUGOSLAVIA

Parallel to the wheat improvement program, and to a certain degree stimulated by the good results obtained in this program, there has been an improvement generally in the agriculture of the country during the last few years. For instance, American hybrid maize varieties have been introduced and widely distributed, and improved cultural practices have been adopted in maize cultivation. The cultivation of sugar beet, lucerne, vegetables, vines and fruit has been intensified. The improvement of root and forage crops is partly facilitated by the good soil conditions in the fields after the highly fertilized and well cultivated crops of wheat.

In connection with the wheat improvement program a series of important scientific studies have been carried out by highly qualified Yugoslav specialists on various important aspects of wheat physiology, wheat diseases and baking quality of wheat. Wheat breeding also has been intensified in recent years.

The consumption of fertilizers has increased from 406,700 tons in 1955 to 1,312,500 tons in 1959, the increase of nitrogen fertilizers being from 144.5 to 421.5, of phosphate fertilizers from 205.5 to 731.0, and of potassium fertilizers from 56.7 to 160.0 thousand tons. The greater proportion of these fertilizers is still imported but the amount produced in the country is rapidly increasing, and according to the program for the construction of factories for fertilizers, started in 1959, there will be a total annual production capacity of more than 500,000 tons of nitrogen fertilizers and 800,000 tons of phosphate fertilizers.

The total amount of agricultural machinery has greatly increased in the last three years. In 1959 there were about 31,000 tractors in use, and many other modern machines, partly imported and partly locally produced, have been assigned to the farmers.

Due to the rapid increase in cereal production there have been some storage difficulties. Numerous silos have, however, been built during the last few years and plans for building many more are ready, the money for which has been provided.

VII. RECOMMENDATIONS

On the basis of the results obtained in the experiments and observations made on the State, Cooperative and private farms, the experts would like to put forward the following recommendations:-

1. The experiments on the different agrotechnical problems should be continued, as more information on the depth of ploughing, soil preparation, fertilization, time and method of sowing, is necessary before the most economical way of growing wheat in different parts of Yugoslavia and on different types of soil can be found.
2. The small-plot varietal trials should continue and should also be extended to those districts where such trials have not yet been carried out. New promising foreign and Yugoslav varieties should be included and those varieties which have given the lowest yield in previous years should be withdrawn. These trials should always be laid out in randomized blocks and it would be advisable to use larger plots than hitherto, preferably 10 - 25 m².
3. In the choice of varieties for large-scale production, not only the yielding capacity of the variety should be taken into consideration, but also such characteristics as winter hardiness, straw stiffness, disease resistance, baking quality, suitability to soil and other environmental conditions, so that in each place the most suitable varieties are used (see page 17). As there are always risks involved if one single variety predominates, several varieties should be used in the same district and even on the same farm, in order to obtain more security in the event of abnormal climatic conditions, and to prolong the sowing and harvesting period.
4. Whenever the recommended introduced varieties are used in large-scale production, great care should be taken in the preparation of the soil, adequate fertilization before sowing and as top dressing, timing of the sowing, cultivation of the fields in spring, weeding by hand, by mechanical weeder or by the application of chemical weed-killers, etc., in order to make it possible to utilize fully the high yielding capacity of these varieties. A better levelling of the land is generally necessary, and, in some areas with clayey soils and where the water table is near the surface, construction of drainage ditches is badly needed.
5. The program for the construction of silos for the storing of wheat, drying platforms and artificial dryers, should be further developed to ensure that the grain can be stored under good conditions.
6. To ensure a sufficient supply of seed of high varietal purity and of high quality, the program for the production of foundation seed of all varieties used in large-scale production, should be further developed. Regulations for multiplication and for field and laboratory control should be issued in all States of the Federation. Sufficient facilities for this control should be provided and steps taken to make sure that these regulations are strictly followed.

7. Studies on the baking quality of introduced and local varieties should be continued and a good balance between these varieties should be created with regard to their quality.
8. The wheat breeding program should be continued intensively, aiming at high-yielding, stiff-strawed, disease resistant varieties, well adapted to the climatic and soil conditions prevailing in different parts of Yugoslavia, and with high baking quality.
9. In those areas of Yugoslavia with special conditions, such as part of Montenegro and Herzegovina, the yielding capacity and the quality of different varieties of durum wheat should be tested, and if good results are obtained the cultivation of that type of wheat should be increased in those regions.
10. Due to the early maturing of the Italian wheat varieties, there is ample time for a more elaborate cultivation of the fields before the next crop is sown. A series of experiments should therefore be carried out in order to find the most economical system for such cultivation.
11. Thanks to the considerable increase in the average yield of wheat, the production is now large enough to cover consumption and in a few years a surplus can be expected. Due to this the acreage under wheat should be gradually decreased, and the cultivation of other crops should be extended, thus facilitating a better crop rotation. Under such conditions special emphasis should be given to the production of annual and perennial leguminous fodder crops.

